Rotating Valve

The invention is related with a rotating valve for high
performance liquid chromatography (HPLC) having a stator
5 with connections for the solvent reservoirs, pumps,
chromatography columns etc. and bore-holes leading from the
connections to orifices in a contact surface, as well as a
disc-shaped rotor with connecting grooves in its front face
for selectively connecting different orifices with each
10 other.

With regard to valves for the high performance liquid
chromatography as for HPLC pumps great effort is made since
long time to achieve as constant transport pressures and
15 flow rates as possible by reducing switching effects. The
smaller the flow rates get, the more disturbing becomes the
effect of dead volumes, which however cannot be fully
eliminated in valves. Equally undesired are strong pressure
pulsations which however increase with continuously higher
20 working pressures due to the compressibility. Both
disturbances result in peak broadening and other errors
which deteriorate the measuring accuracy and the
resolution. Presently requested flow rates are in the range
of 10 µl to200 um and desired pressures reach already up to
25 800 bar. Satisfactory achievement of these requirements
with conventional valves is possible not any more or only
with high effort.

It is therefore the object of the invention to provide a
30 valve with which these negative effects can be reduced with
reasonable effort.

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According to the invention   this is achieved with a valve
of the type mentioned initially in which the orifices in
the contact surface are distributed equally over two
concentrical circles and the connecting grooves in the
5   rotor front face are configured as an arc of a circle and
are arranged such that in defined rotor positions fife
orifices are simultaneously interconnected on each circle.

In the   following preferred embodiments of the invention
10   are described with reference to the accompanying drawings.
It is shown in

    Fig. 1   a schematic diagram of a rotating valve
                  according to the invention

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    Fig. 2 - 6   a binary gradient pump system with a valve
                  according to the invention in different
                  switching positions.

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The rotating valve schematically shown in Fig. 1 consists
essentially of a disc-shaped stator 1 and an equally disc-
shaped rotor 2. In the stator altogether eighteen through-
holes 3 are arranged such that their orifices at the
25   contact surface 4 facing the rotor are equally distributed
over two concentrical circles 5,6. At the backside
connections 7 are provides for connecting lines to pumps,
solvent reservoirs, chromatography columns etc.

30   The rotor 2 has on its front surface 8 facing the stator
two arc-shaped grooves 9,10 which in the assembled state of
the valve, when the front face of the rotor is pressed
against the contact face of the stator, extend along the
circles on which the orifices of the holes 3 are

positioned. The length of the grooves is dimensioned such that each can connect simultaneously five orifices of the holes on its respective circle.

5   With nine hole orifices per circle the angular distance between two orifices comes to 40°, so that the grooves need to extend over an angle of about 160° to connect five orifices. They are arranged such that each of them has one end at one common angular position, from where one of them
10   extends in clockwise and the other in counter-clockwise direction.

In the configuration shown in Fig. 2 the valve exhibited in schematic top view is connected with two piston pumps
15   11,12, two solvent reservoirs 13,14, and two exits to a gradient system for the solvent feeding to a chromatography column. At the connection of the outer circle 5 located in the angular position 0° a pump 11 is connected for the solvent A contained in reservoir 13. The respective 0°
20   connection of the inner circle is connected with the other reservoir 14 containing the solvent B. The second reservoir 13 with the solvent A is connected to the connection located in angular position 160° of the outer circle. To the respective connection of the inner circle the second
25   pump 12 for the solvent B is connected. Eventually, the connection at 280° of the outer circle and the connection at 240° of the inner circle lead to the exit towards the column. These two exits are combined in a mixer (not shown) as usual.
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In the rotor position shown the connection of pump 11 for solvent A is linked with the connection for the respective reservoir 13 via the outer groove. Thus, in this position pump 11 can draw solvent A. At the same time the connection

for the other pump 12 for   solvent B is linked via the
inner groove to the connection for the respective exit 16.
Thus, in this rotor position this pump can transfer the
solvent B contained in it towards the exit or column

5   respectively.

Between the pumps and the respective valve connections
highly sensitive pressure transducers 17 are arranged the
signals of which are used for pump and valve control.

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Fig. 3 shows the same configuration in which the rotor is
rotated by one angular position in counter-clockwise
direction after the end of the drawing process of pump 11.
Now, no other connection except the pump connection runs

15   into the outer groove, so that pump 11 can compress the
previously drawn solvent A until the necessary or desired
transport pressure is reached. For the solvent B nothing
has changed by the switching. The other pump 12 is still
connected via groove 10 to the exit 16 and continues to

20   transport uniformly.

When solvent A has reached the desired pressure and the
transport of both solvents is to start, the rotor is
rotated by a further angular step in counter-clockwise

25   direction into the position shown in Fig. 4. In this
position both pumps are connected with both exits. The
mixing ratio of the two solvents is controlled via the
forward movement of the two pumps.

30   When the transport of solvent B by pump 12 is finished and
only solvent A is still transported, the rotor is rotated
by two angular steps in counter-clockwise direction into
the position shown in Fig. 5. In this position pump 11 is
still connected to exit 15 via the outer groove 9, while

the inner groove 10 connects pump 12 to reservoir 14 of solvent B. Pump 12 can now again refill with solvent B.

5 By rotor rotation in backward direction, i.e. clockwise, the respective steps take place in opposite sequence. After the end of the filling procedure the rotor is turned in clockwise direction by one angular step. In this position shown Fig. 6 the inner groove does not provide any connections so that pump 12 can pre-compress the solvent to

10 the desired transport pressure. For pump 11 nothing has changed, i.e. it can continue to transport uniformly. There are further rotor turns in clockwise direction until the situation according to Fig. 2 is reached again.

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